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INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

WORK OF THE EXPERIMENT STATIONS OF THE BUREAU OF MINES

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Most of the technologic work of the Bureau of Mines is carried on at eleven Experiment Stations located as follows: Bartlesville, Oklahoma; Berkeley, California; Birmingham-Tuscaloosa, Alabama; Minneapolis, Minnesota; New Brunswick, New Jersey; Pittsburgh, Pennsylvania; Reno, Nevada; Rolla, Missouri; Salt Lake City, Utah; Seattle, Washington; and Tucson, Arizona. The following paragraphs give brief descriptions of the work being done at each of these stations.

A summary of titles will be found on page 23 .

PETROLEUM EXPERIMENT STATION, BARTLESVILLE, OKLAHOMA.

a. Investigation of methods of handling producing wells. A study is being made to determine the most satisfactory methods of producing oil from wells under different field conditions.

b. Investigation of mud fluid for oil and gas well use. Mud fluid is used in drilling oil wells to aid the cutting action of the bit and to hold back gas and water in the formations penetrated. The properties of different materials are being studied to obtain fluids that are best suited for different conditions.

c. Separation of wax from lubricating wax distillates. Much oil that could be made into satisfactory lubricants is now burned as fuel because no entirely successful method has been developed for removing the wax. Present methods are being investigated as a starting point toward the development of more practical processes.

d. Study of crude petroleum. Until the composition of crude petroleum is known, the most efficient use can not be made of it and its products. Therefore the compounds of crude petroleum are being isolated and studied.

e. Shooting of oil wells. Data are being assembled on the practices of shooting wells to increase the production of oil. These data include kinds of explosives used, methods of detonation, and the amount of explosive for various formations.

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f. Methods of increasing the recovery of oil. Engineers have estimated that present methods of oil recovery allow 80 to 90 per cent of the oil to remain underground. To increase the recovery from the sands, air lift, repressuring with gas and air, water flooding and other measures are being studied in the field and laboratory.

g. Investigation of sulphur compounds in crude oil. The biggest single problem in petroleum refining is the elimination of sulphur. Data in regard to sulphur compounds in petroleum are of the greatest importance. Attempts are being made to isolate these compounds, and new methods for their detection and estimation have been worked out.

h. Investigation of the use of gas for lifting oil. A fundamental study of the principles involved in the use of gas and air lift methods is being directed toward determining installations which will lift the oil efficiently.

i. Study of the flow of natural gas through pipe lines. The flow of gas through transmission lines is being studied to determine the most economic types of installations.

j. Study of Oklahoma asphalt. Methods are being developed for segregating the true asphaltic deposits from other materials that are somewhat similar in character but are unsuitable for highway construction.

k. Study of disposal of oil field waters. The contamination of streams by the saline waters that are produced with petroleum is being studied. The possibility of obtaining certain commercial salts from these waters opens a way to convert a waste into an economic asset.

l. Study of evaporation losses of petroleum and gasoline. Results obtained by the commercial application of methods and equipment for the reduction of losses by evaporation are being studied. These investigations are being presented to the petroleum industry in a way that enables the operator to choose the method and equipment best suited to his particular problems.

m. Chemical treatment of light petroleum distillates. Experimental studies were made on the chemical treatment of gasoline and similar products and the conclusion was reached that isolating and treating fractions containing undesirable substances is cheaper and better than treating the gasoline as a whole.

n. Safety work. The cause of accidents and methods for their prevention in the Mid-Continent oil field are studied and information disseminated.

FIELD OFFICES

In addition to the work at Bartlesville, petroleum studies are also conducted at Dallas, Texas; Laramie, Wyoming; and San Francisco, California. Oil shale studies are carried out at Boulder and Rifle, Colorado. Since the work of these field offices is closely associated in subject matter with that at Bartlesville, a report on their problems is inserted at this point.

Dallas, Texas

Engineering reports on producing fields. Engineering studies of the methods of oil production in different fields, the mapping of producing sands, the methods used to prevent water encroachment, etc., are studied in producing areas, and recommendations leading to more efficient recovery of oil on the basis of previous similar studies are made to the operators. Fields where engineering reports have been or are being prepared include Seminole (by Bartlesville staff), Powell, Wortham, Putnam and Texhoma-Gose.

Laramie, Wyoming

a. The deposition of paraffin in oil wells - the cause, effect, and measures used to overcome the resulting difficulties. In certain districts, paraffin deposits often clog the face of sands and the casing in wells. The cause of such clogging has been studied and some preventative methods have been devised.

b. Laboratory study of physical characteristics of paraffins and waxes. Data on the physical characteristics of paraffins and waxes occurring in crude oil have been obtained as an aid in understanding the cause for an elimination of the deposition of paraffin in wells.

c. Study of methods for producing flowing wells in the Rocky Mountain region. A study is being made of methods for reducing the amount of gas produced per barrel of oil. The solution of this problem will decrease the cost of production.

San Francisco, California

a. Salvages in the oil industry. Millions of dollars are expended annually in the United States in the purchase of new mechanical equipment used in the oil industry, without proper attention being paid to the possibility of reconditioning used material. A study of this subject and dissemination of the information gained should be of great value to the oil industry.

b. Engine tests on lubricating oils. A series of dynamometer tests has been made on various lubricating oils. The influence of viscosity, volatility, and other properties of lubricants is being studied in relation to consumption of both fuel and lubricating oil in internal combustion engines.

c. Methods of producing oil wells in California. An engineering study is being conducted on methods of oil production with particular reference to conditions which are characteristic of California, such as deep well drilling and pumping.

d. Bibliography of petroleum and allied substances. To meet the demands of the oil industry and libraries, a bibliography covering petroleum, natural gas and allied substances is prepared monthly and annually.

e. Safety in the natural gas gasoline industry. Information regarding safe and unsafe practices in this industry is being collected and will be published by the Bureau.

f. Thermal decomposition of oil-shale kerogen. The chemical reactions involved in the formation of shale-oil are being studied in the hope of securing information regarding the origin of petroleum.

Boulder and Rifle, Colorado

a. Investigations of experimental retorts and development. Oil shale retorts are investigated and production data obtained whenever possible. Such data lead to proper selection of equipment for specific conditions.

b. Refining study and analytical distillation of shale-oil. Analytical distillations are made on shale-oils to obtain information regarding their composition. The effect of various refining agents and of different methods of distillation on the composition of the oil can thus be determined and methods developed which produce the maximum amount of desirable products.

c. Assay retort studies. The Bureau has developed an assay retort for oil-shale in which samples of shale can be tested for oil content, and in which the conditions most favorable for maximum oil yield can be determined.

d. Study of nitrogen compounds in oil-shale and shale-oil. The kind and amount of nitrogen compounds present in oil-shale and shale-oil and their value as by-products are being determined.

e. Extraction and analysis of kerogen. Unchanged kerogen (the substance producing shale-oil) is being extracted from the shale, and its characteristics and relation to crude oil are being studied.

f. Weathering tests on oil-shales. The effects of weathering on the amount and quality of shale-oil produced from representative American shales is being studied.

g. Effect of inert gases on production of oil from oil-shale. These tests are being conducted in an effort to increase the quality and quantity of the shale-oil.

h. Experimental refining of shale-oil. Experiments are conducted to develop the best methods for refining shale-oil after it is secured from the shale

PACIFIC EXPERIMENT STATION, BERKELEY, CALIFORNIA

a. Reduction of metal oxides. Equilibrium diagrams for the reduction of different metal oxides by carbon or reducing gases are being worked out. These results supply fundamental data heretofore lacking and greatly needed in working out new and improving present methods of refining various oxide ores to their metals.

b. Reduction of cuprous oxides. The equilibrium composition of gases resulting from the reduction of cuprous and cupric oxide to copper is being determined at different temperatures. This is urgently needed in the work of the Bureau of Mines on improving copper smelting methods.

c. Specific heats of oxides and sulphides. Data on the specific heats of the common ore minerals are used for calculating metallurgical heat balances in the treatment of these minerals and in calculating other data from which reactions can be predicted and equilibrium constants at different temperatures calculated. These have not been determined over the temperature range required in modern metallurgy. The Bureau's work is supplying this need.

d. Heats of formation of oxides and sulphides. More fundamental data not now available are being secured from these experiments, the results of which can be interpreted into heat conservation in various metallurgical processes.

SOUTHERN EXPERIMENT STATION, BIRMINGHAM-TUSCALOOSA, ALABAMA

a. Beneficiation of low-grade bauxite. There are at present many low grade bauxite deposits containing gangue material, especially silica, iron and titanium, which makes them objectionable for use as a source of aluminum. This study will lead to the development of methods of treatment for removing the objectionable impurities.

b. Beneficiation of low-grade phosphate ores. A similar problem exists in the phosphate industry. Experiments are being conducted which will lead to commercial processes for making available low grade phosphate deposits and eliminate certain wastes now occurring in the operation of existing deposits.

c. Coal washing problems in Alabama. Many of the Alabama coals are of a grade which require washing to reduce the ash content sufficiently to compete on the open market with the higher grade coals. The Bureau of Mines is conducting experiments in coal washing with the hopes of enlarging the field of usefulness of many Alabama coals.

NORTH CENTRAL EXPERIMENT STATION, MINNEAPOLIS, MINNESOTA

a. Separation of manganese, iron and phosphorous in high-phosphorous spiegel. For several years the Minneapolis Station of the Bureau of Mines has been investigating the metallurgical problems connected with the use of the manganiferous iron ores of Minnesota with the ultimate aim of making this country independent of imported ferro-grade manganese ores in time of national emergency. This problem is one phase of the larger investigation.

b. Resistance offered to flow of gas by columns of irregular solids. The efficiency of the blast furnace process depends to a large extent upon contac between gas and solid. The distribution of gas through the stock column is controlled by the relative resistance of various portions of the charge. This resistance is being carefully measured and the results interpreted as far as possible in improved practices in the distribution of raw materials in the furnac

c. Transfer of heat from a moving gas stream to a column of irregular solids. The Bureau of Mines is studying the transfer of heat from a moving gas stream at varying temperatures and rates of flow to beds of solid particles differing in size, density and heat conductivity. The results will be applicable to a number of commercial processes, chiefly the blast furnace.

d. Kinetics of iron ore reduction. Experiments are being conducted to determine the influence of gas composition, pressure, temperature, size of ore particles and rate of gas flow upon the ore reduction reactions. Such data should lead to improvements in blast furnace practice.

e. Comparative desulphurizing power of blast-furnace slags containing small percentages of barium oxide. It has been suggested that the addition of small percentages of barium oxide to blast furnace slags will materially increase their desulphurizing power. This is being checked experimentally.

f. Plant observations on the reactions in the iron blast-furnace. From accurate scientific measurements of the gas compositions, pressures, velocities, etc., at different points of the blast furnace under operating conditions many fundamental data on the effect of various furnace practices have been obtained. These studies have led to improvements in the past and are being continued.

NONMETALLIC MINERALS EXPERIMENT STATION, NEW BRUNSWICK, NEW JERSEY

a. Production and use of metallurgical limestone. A study has been made of the requirements regarding size and quality of limestone for different metallurgical purposes and at the same time of the quarry problems connected wit their production. Such correlation of the producers' and consumers' problems will lead to more economic methods of production and utilization.

b. Occurrence, mining and milling of mica. The present methods of securing and treating mica under different natural conditions have been studied and more efficient methods of ore treatment and grinding developed.

c. Application of the wire saw in slate quarrying. It is said that 75 to 90 per cent of the gross production in the slate industry is wasted by the present quarry methods. Tests of the wire saw in several slate quarries have shown that much of such waste can be eliminated. The work is being extended to different slate producing regions.

d. Digest of literature on Stassfurt and Alsatian potash. At the present time great interest is being shown in the United States in the development of a domestic potash industry. For that reason the literature in regard to the foreign deposits is being abstracted and whatever helpful information it may contain is being secured. This is being applied to laboratory studies of our own potash minerals.

e. The concentration and treatment of potash ores. A chemical study is being made of the methods of concentration and purification of the potash minerals found in commercial quantities in the drill cores from the southwest. Commercial processes of treatment are also being developed.

f. A field study of the utilization of greensand. Much greensand occurs in readily available deposits in New Jersey and other states. A study is being made of the possibilities of commercial utilization of these deposits as a source of potash.

g. The effect of anhydrite in cement retardation. Report of investigation No. 2705 on calcium sulphate retarders for Portland cement has aroused much interest in this work. The present study is on the effect of fineness of anhydrite on retardation and the effect of different anhydrites.

PITTSBURGH EXPERIMENT STATION, PITTSBURGH, PENNSYLVANIA

Coal and Coal Products Research Section

Analytical Laboratory

a. Miscellaneous analytical work Much analytical work arises in connection with studies conducted by the Bureau of Mines. Materials analyzed include furnace slags, clinkers, ores, minerals, dusts, explosive residues, drill cores, boiler scales, etc. Several hundred determinations a month are made on such material.

b. Coal ash fusibility as related to clinker formation. In the past there has been no entirely satisfactory method of predicting the clinkering quality of a coal, although coal ash fusibility has been regarded as somewhat of an indication. In the present problem the analytical laboratory has made determinations of the fusibility of coal ash and correlated the results so obtained with the clinkering of the coal under furnace conditions, as determined by the Fuel Section.

Microscopical Laboratory

a. Microscopic studies of coal. The microscopic study of thin sections of coal has shed much light on the question of its origin by showing the components of different ranks of coal and coal of different physical properties. Furthermore, certain correlations are possible on this basis.

b. Chemistry of decay in relation to peat and coal formation. The principles underlying coal formation and the origin of certain constituents in the coal are being carefully studied.

c. Relation between composition and oxidizability of coal. A systematic series of samples, representing the various stages of coalification from peat to anthracite, are being examined microscopically and chemically to determine which constituents are responsible for spontaneous combustion.

Coal Carbonization Laboratory

a. Spontaneous combustion of coal. The sensitivity of various coals and coal constituents has been determined. The physical factors involved in the spontaneous combustion of coal have also been studied.

b. Determination of reactivity of coke in air, carbon-dioxide and water vapor at various temperatures. The relative ease of ignition and rate of combustion of coke have been determined in the past by various methods. These methods have been studied to correlate the results. Information has also been secured on the relation of the physical properties and method of manufacture to coke reactivity.

c. Oxidation of sub-bituminous coal at low temperatures. The internal structure of the molecule of the main mass of coal by the isolation of various parts of a typical sub-bituminous coal is to be determined. This problem is being carried out by British cooperation.

d. Survey of methods for determining gas and coke making properties of coals. Several methods are now in use for testing the value of a coal for carbonization purposes. Unfortunately some of these do not give results comparable to commercial practice. The Bureau of Mines is studying the value of these various tests and hopes to arrive at a practical moderate scale test method.

Organic Chemistry Laboratory

a. Constitution of low temperature tar. Almost nothing is known regarding the chemical compounds found in tar resulting from the low-temperature carbonization of coal. With this latter process becoming increasingly important a knowledge of the products formed is highly desirable and even necessary before cost sheets can be prepared for commercial operations.

Physical Chemistry Laboratory

a. Production of methanol. The personnel of the Coal Carbonization laboratory, the Organic Chemistry Laboratory, and the Physical Chemistry Laboratory, are cooperating on several problems regarding the production of synthetic motor fuels. The production of such fuels abroad has reached an important stage of development and American attention has recently been drawn to them by the purchase of certain patents by several American oil companies. Little is known, however, of the intimate details of these foreign processes. The Bureau of Mines has been actively engaged in similar research, chiefly on the production of methanol from carbon monoxide and hydrogen.

Health Laboratory Section

a. Miscellaneous gas analysis. In connection with many investigations conducted by the Bureau of Mines, especially field studies in coal mines, investigations after explosions or fires, places thought to contain some harmful gas, etc., gas samples are collected. These are analyzed and the results interpreted in the light of past experience.

b. Miscellaneous pathological studies. It is frequently necessary to make pathological studies in connection with other problems. Such work includes toxicity data, pathological changes under various conditions, etc.

c. Routine tests of gas masks and dust respirators. As new or improved masks and respirators come on the market, it is desirable to test them for safety and efficiency.

d. Physiological effect of various dusts on animals. The Bureau has been interested for a number of years in the effect on men of industrial dusts encountered in mining operations or factories. Data regarding a dust composed of but one mineral will give fundamental information. Hence, experimental work is being conducted on the effect of certain mineral dusts on animals.

e. Experimental effect of oxygen upon animals. Men doing mine rescue work are compelled to breathe high oxygen concentrations over long periods of time. In order to determine the effect of such exposure, animals were confined in atmospheres of 95 to 98 per cent oxygen under various conditions for various intervals of time and the effects noted.

f. Disposal of waste waters from mines. Recently considerable attentior has been directed to the question of stream pollution by acid mine waters. The Bureau of Mines is gathering data on this subject and attempting to devise feasible methods of preventing such pollution.

g. Sealing abandoned mines and determining the cause of alkalinity in others. The Bureau of Mines is gathering information concerning the effect on the composition of mine drainage of sealing abandoned mines and portions of mines so as to exclude air. Certain results indicate that this may result in a decrease in acid water in the overflow.

h. Pathology of carbon monoxide poisoning. The Bureau of Mines has been a pioneer in studying carbon monoxide and the emergency treatment for such poisoning. However, up to the present time we have but little knowledge of the pathological changes attending it. Such information will assist in developing better treatment.

i. Relative toxicity of methyl chloride, ethyl chloride, methyl bromide and ethyl bromide. These compounds are being used or proposed for use as refrigerants. Knowledge of their toxicity, should they escape into the air, is important.

j. Temperature and humidity investigation. Information regarding the physiological reactions attending periods of work at high temperatures and humidity together with such work followed by rest periods under temperature conditions more favorable to comfort, is being obtained. The relation between the heat generated by the body, evaporation and comfort is also being studied.

k. Carbon monoxide recorder. During the past three years the Pittsburgh Station of the Bureau of Mines has developed an instrument for recording extremely minute concentrations of carbon monoxide in air. Work on the improvement of this apparatus and the extension of its usefulness is still in progress.

l. Occluded gases in coal as affecting inflammability of its dust. The gas absorption power of coal and the influence of various absorbed mine gases on coal dust explosions is being determined.

m. Warning agents for manufactured gas. In cooperation with the American Gas Association, the Bureau of Mines is studying the chemicals which might be added to gaseous fuels to warn of their presence in air by sensory action.

n. Sulphur dioxide in air. Wire screens of various compositions are being exposed to atmospheric conditions over long periods of time. To correlate the resulting corrosion with atmospheric composition, the sulphur dioxide content of the air is being determined daily.

o. Catalysts for automobile exhaust. Catalysts have been suggested as a means of eliminating the carbon monoxide hazard from automobile exhaust gases. Certain existing catalytic materials are being tested for efficiency in this capacity.

Explosives Section

a. Tests of explosives to determine their permissibility for use in coal mines. It is well recognized that not all explosives can be safely used in gaseous coal mines. Consequently the work of the Bureau in determining the permissibility of explosives is highly important.

b. Analysis of explosives and explosive materials. In connection with the research problems of this section, it is necessary to analyze many explosives and explosive materials.

c. Collecting and testing field samples of permissible explosives. In order to maintain the standard of permissible explosives, samples are collected in the field and checked against those submitted by the manufacturers.

d. Factors influencing the nature and quantity of poisonous gases liberated by explosives under mining conditions. The Bureau is determining the amount and composition of products of detonation of explosives under field conditions, with special reference to the poisonous and inflammable gases produced. At the same time, the effect of different factors met under actual mining conditions on these products of detonation is studied.

e. Determination of limit charge curves for permissible explosives in varying gas-air mixtures. Information is being secured regarding the charge limit gas composition curves of methane-air and natural gas-air mixtures, using explosives of different kinds and in varying quantities with different types of detonation and stemming.

f. Investigation of explosions due to explosives. By studying the various catastrophes resulting from explosions it is hoped to develop better methods for handling explosive materials.

g. Photographic study of the process of ignition of gas-air mixtures by explosives. Fundamental data on the mechanism of ignition and the manner of propagation at the time and immediately following actual ignition are being obtained.

h. Investigation of new explosives and of new components for explosive mixtures. New explosives and new components for explosives mixtures are frequentl being proposed and often adopted by the manufacturers. These are studied and passed upon by the Bureau. Glycol dinitrate has recently been the subject of such an investigation and is now accepted as a component of permissible explosives in substitution for part of the nitroglycerin.

i. Effect of carbon dioxide, nitrogen and helium on the limits of inflammability of carbon monoxide and hydrogen. Information has been secured regarding the amount of oxygen that must be present to cause hydrogen and carbon monoxide when diluted with inert gases to propagate flame. These data will be useful in considering whether the gases behind seals in mine fires and the detonating gases from explosives are inflammable and within what limits.

j. Determination of the temperature attained by the products of detonation of explosives. The temperature of the flame produced by detonation of explosives is believed to be one of the factors affecting the liability of ignition of inflammable mixtures by explosives. Calculated temperatures are probably in error due to lack of data on specific heats at high pressures and temperatures. Direct determination of the temperature is highly desirable.

k. Effect of confinement and nature of stemming and tamping on the charge limits of explosives. The effect of various methods of loading and kinds of stemming on the safety of explosives is being determined by gallery tests.

l. Velocity of detonation across a gas-gap between two cartridges of explosives. The velocity of propagation of detonation across a gap between two cartridges of explosives when the gaps are filled with various gases is being studied.

m. Metal mine explosives and blasting methods. The types of explosives in use under different mining conditions and the corresponding methods used in blasting are being studied to obtain information regarding the best explosive and blasting practice under particular conditions.

n. Development of analytical testing methods. In order to keep the laboratory at its highest efficiency, new methods suggested by others are tested and evaluated and, when necessary, original methods devised.

o. Relation between oxygen balance and explosive properties of eight samples of forty per cent gelatin dynamite. The explosive strength and gaseous products of detonation of a series of eight dynamites of varying oxygen balance are being determined.

Fuels Section

a. Refractory service survey in boiler furnaces. In the past we have been uninformed in regard to the conditions to be withstood by boiler furnace refractories. This study of temperature, gas, dust, coal and slag compositions will show the conditions existing within the furnace for which proper refractories must be developed.

b. Soot remover and soot prevention compounds. Products advertised as the above have been tested to ascertain whether the manufacturers' extraordinary claims are justified.

c. Heat flow meters for furnace walls. In connection with many investigations of the Fuels Section it is necessary to know the flow of heat through furnace walls. A meter suitable for measuring the high temperature losses in kil and furnaces is being developed.

d. Tests of secondary air devices for domestic furnaces. Tests are bein made of the value of appliances to admit secondary air to the combustion space of heating furnaces.

e. Coal ash fusibility as related to clinker formation. The correlation of the amount, type, and composition of clinkers from a furnace with the chemical investigation of fusibility of coal ash, mentioned under the Coal and Coal Produc Section, is being carried out.

f. Determination of relative availability of cokes for use in domestic heating furnaces. A standardized burning test including ease of starting, overall combustibility, secondary air requirements, refuse loss, clinkering trouble, attendance requirements and effect of size of coke pieces, is being devised and various cokes tested by such standards.

g. Rating of low pressure heating boilers. The American Society of Heating and Ventilating Engineers has proposed a code for the rating of low pressure boilers. The application of this code is being tested, details of conducting the test developed, the influence of different fuels determined, and the effect on the rating caused by varying some of the limits specified in the code studied.

Metallurgical Section

a. Study of the cause and control of abnormality in case carburized steel. Ability to control the abnormality of case carburized steel will lead to the production of a better product.

b. Equilibrium between iron, manganese and sulphur. The factors affectin the desulphurization of pig iron by manganese, such as time, temperature, concentration of manganese and sulphur, presence of other elements, effect of slag, etc., are being studied.

c. Physical chemistry of steel making. In cooperation with the Carnegie Institute of Technology and an Advisory Board from the metallurgical industry, a five-year program on this subject was outlined. It includes work on the following problems of fundamental importance to the steel industry.

d. Distribution of iron oxide between slag and metal. The equilibrium constants of this fundamental physico-chemical reaction which occurs in the processing and refining of steel are being studied and determined.

e. Formation and identification of non-metallic inclusions. Many trouble from faulty steel are due to non-metallic inclusions. The Bureau is studying the mechanism of their formation, methods for their identification, and their effects in the manufacture of steel, particularly the influence on rolling and the physica properties of the steel, and their elimination during various steel-making processes.

f. Viscosity of open-hearth slags. Data are rapidly being secured on the variation of slag viscosity with composition. Viscosity influences the rate of diffusion and therefore the equilibrium between the various constituents in metal and slag.

Coal Analysis Section

a. Laboratory work on coal analyses. Samples taken in connection with the purchase of coal on specification by various Government departments, together with samples from combustion research, testing of fuels, investigation of mine explosions, classification of coals or coal-fields, etc., are analyzed by this section.

b. Development of methods and equipment. Part of the duty of this section lies in keeping its work at the highest pitch of accuracy by improvement in methods or materials.

Physical Section

Physical Laboratory

a. Accuracy of manometry of explosions. There are several different instruments for measuring the rapidly changing pressures of explosions produced by gas and dust, such as the B.C.D., the Bureau of Mines, the Crosby Gauge, and the Piezo-electric manometers. Comparative measurements with these different instruments should give standards with which to view results by different methods.

b. Relative ignitability and pressure developed in the flammation of low-temperature coke as compared to coal. Powdered coal has become a fuel of importance. In order to obtain data regarding the combustibility of powdered low-temperature coke, looking toward its use for a similar purpose, the present study was undertaken.

c. Routine calibration. The accurate instruments, such as pyrometers, thermometers, gauges, electrical measuring devices, etc., used by the various investigators in the Bureau of Mines need occasional calibration. The physical laboratory takes charge of this work.

Cryogenic Laboratory

a. Vapor-pressure composition relations for methane-ethane mixtures.

b. Vapor-pressure composition relations for methane-nitrogen mixtures. In the majority of natural gases from which helium is isolated in large-scale production, methane and nitrogen are the constituents present in the largest relative proportions. The method employed for the isolation of helium involves liquefaction of the constituents of the helium-bearing gas, at high pressures and low temperatures, except the helium which remains as gas and is pumped off as such. It is, therefore, essential for the design of efficient helium production processes to develop as many research data as possible concerning the physical properties of coexisting liquid and vapor phases of methane and nitrogen, and als methane and ethane (since the latter hydrocarbon is also present in the natural gas, often in considerable quantity) under the above indicated conditions of pressure and temperature, with special reference, in these two problems, to compositions, vapor pressures, and specific volumes of the methane-ethane and methan nitrogen systems.

c. Specific heat of liquid ethane. Since ethane forms one of the constituents of natural helium-bearing gases, it is essential for the efficient production of helium from such gases, through liquefaction methods, to develop data with regard to ethane in the liquid state. Specific heat of liquid ethane is one of the properties of importance in this connection.

d. Removal of carbon dioxide from natural gas by refrigerating organic solvents. Helium-bearing natural gases contain more or less carbon dioxide which must be removed before the application of the process for separating helium, i.e., by means of liquefaction. Carbon dioxide is removed, in standard practice, with caustic soda. The feasibility of accomplishing the removal with possibly greater efficiency by solution or absorption of this gas in certain selected appropriate liquids at low temperatures is the subject of this problem. The design of a carbon dioxide removal unit along these lines was tentatively worked out some time ago, and trials in a laboratory scale plant were begun; the problem has, however, since then been in abeyance.

e. Search for neon in natural gas. Natural helium-bearing gases have been examined for possible neon content. Since it is impracticable to separate neon from helium on a large scale, the isolation of helium from a natural gas containing any considerable quantities of neon would result in obtaining helium contaminated to that extent with an element of practically five times its own weight, or about 7/10 the weight of air, and such helium would, therefore, not be serviceable for practical aviation purposes.

f. Heat transfer at low temperatures. Helium production from natural gas by means of liquefaction processes necessarily involves the subject of the transfer of heat from one fluid to another at low temperatures through metal walls; and the determination of the physical factors involved in such transfer is necessary for the efficient operation of such processes.

Experimental Mine Section

a. Efficacy of devices for arresting an explosion after it has traveled some distance. The value and limitations of various rock-dust barriers limiting an explosion are being tested. At the same time, a standard schedule of tests for such work is being developed.

b. Behavior of different coal dusts as regards propagation of flame. Coal dusts from typical mines in various districts are tested for ease of explosibility in air alone and in air with small percentages of natural gas to determine the explosion hazard of the mine in question. Chemical analyses of the dusts are also made and correlations between composition and explosibility are attempted.

c. Recirculation of air by auxiliary fans. An auxiliary fan under certain conditions will retake air from that which it has already sent to the working face. If firedamp is liberated at the face an explosive mixture may be accumulated. The conditions under which this may occur are being determined. The first phase has been completed and is being written up.

Electrical Section

a. Routine tests and approval of apparatus. One of the Bureau's closest contacts with industry is the work performed in connection with the investigating of various types of electrical mining equipment to determine its safety when used in mines which are gassy or may become so. Equipment tested includes small apparatus like lamps and shot-firing equipment and large equipment like coal-cutting machines, loading machines and locomotives. The industry voluntarily submits this equipment for inspection, test and approval and many operators refuse to use anything else.

b. Ignition of methane by heated surfaces. What causes some of those mysterious mine explosions? Is it the overheated mining machine bit? Is it the friction spark from a sulphur ball? Is it rock sliding down an iron chute? Is it rock grinding against rock? The Bureau hopes to answer some of these questions from the knowledge gained by research on the ignition of methane by heated surfaces.

c. Adequacy of flame safety lamps for gasoline vapors. For over a hundred years the flame safety lamp has been a recognized means of detecting gas in mines. During the last three or four years the question of the suitability of flame lamps for use in detecting gasoline vapors has come to the front. The inspection of large oil tanks and places where gasoline may collect is a very important matter. The oil industry is, therefore, very much interested in the investigation that the Bureau has undertaken to determine the safety of flame-safety lamps for this class of service.

Mining Research Section

a. Comparative efficiency of storage battery and trolley mine power. The conditions under which storage battery power can favorably compete with other electrical power for coal mines, not only for haulage and gathering locomotives, but also for mining machines, pumps, etc., are being studied. Use of storage battery power would materially reduce the explosion and shock hazard incident to exposed wires.

b. Coal mine ventilation factors. The various factors influencing the ventilation of coal mines have been worked out and are being prepared for publication.

c. Operation of mine fans. The performance of various types of fans, in various arrangements, has been studied.

Falls of Roof and Coal Section

a. Falls of roof and coal. More accidents in coal mines are caused by falls of roof and coal than by any other single cause. Studies of the circumstances under which accidents occur from falling of material from roof or sides with a view to determining methods and practices which will give promise of prevention of accidents from these causes are being actively pursued.

RARE AND PRECIOUS METALS EXPERIMENT STATION, RENO, NEVADA

a. Precious metal loss in present milling practice. Various minerals bearing small amounts of precious metals are lost in tailings under present methods of treatment. The Reno Station is locating such losses and developing methods for the elimination of the waste.

b. Cyanide recovery of precious metals associated with minor copper values. The extension of cyanide recovery of precious metals to ores containing copper values under present smelting practice is being considered. The action of each copper mineral in cyanide recovery is being studied separately to secure the facts regarding their behavior during such treatment.

c. Metallurgy of chromium. The Reno Experiment Station is studying the metallurgy of chromium and developing methods of treatment applicable to domestic ores. This is especially important at this time, since we are using so much corrosion-resistant steel.

d. Recovery of radium now wasted. An improved process for the recovery of radium from low grade carnotite ores which are now being mined and milled for their vanadium content only is being devised. This by-product radium is now discarded in the tailings.

e. Centrifugal concentration. Many highly oxidized ores containing base and rare metals do not respond to the usual concentration methods. This is particularly true of the slime portion. The possibility of centrifugally concentrating these ores is being studied with favorable results to date.

f. Hydrometallurgy of manganese. The work on the utilization of domestic manganese at the Minneapolis Experiment Station is pyrometallurgical. The Reno Experiment Station is improving and developing hydrometallurgical processes for the treatment of domestic low grade ores to obtain a marketable grade at a price that will insure successful competition with the present imported supply.

g. Oil bleaching clays. Certain clays are extensively used by the oil industry for bleaching their product. At the present time there seem to be no specifications of value to producers, users, and the public in general. It is hoped in the course of this study to develop them.

h. Identification of rare and non-metallic minerals. To satisfy the demand for reliable identification of ore minerals, particularly of the rare and precious metals, the Reno Experiment Station examines approximately 50 to 75 samples each month.

MISSISSIPPI VALLEY EXPERIMENT STATION, ROLLA, MISSOURI

a. Concentration of fluorspar ores in the Illinois-Kentucky district. Most of the fluorspar ores in this district carry large amounts of impurities, while the demand is for material assaying 85 to 99% spar. The best methods and equipment for the concentration of the fluorspar are being studied. Already methods have been developed to produce a 97% spar and the end of the improvement has not been reached.

b. Improvements in the milling of Southeast Missouri lead ores. While the milling practice of this district is at present good, it is forced by a progressively leaner mill feed to look for improvements which will permit successful operation. The reduction of the amount of lead in the tailings has been accomplished. The development of zinc ores in some of the mines and copper ores in others will be a factor compensating to some degree the decreased lead when a process is successfully worked out for their recovery.

c. Improvement of milling practice in the Tri-State Zinc district. The zinc ores of this district are yearly becoming leaner and more complex. Zinc resources will be conserved and the life of the community prolonged if methods can be developed under which this lean ore can be successfully worked. First results have led to a remodelling of the mills of the district to conform to Bureau of Mines suggestions.

d. Gravity concentration of oxidized zinc ores occurring at Gramby, Missouri. This district is an old time mining camp which has been abandoned because the ore could not be profitably milled. Recently an effort has been made to reopen some of the mines in this locality. The Bureau is attempting to develop successfully concentration methods for the oxidized zinc occurring there.

e. Means of making a segregate preparatory to chemical analysis of the sulphide minerals in a low grade domestic ore-pulp containing lead, zinc and copper. Present methods of assaying tailings containing less than 0.1% lead are unsatisfactory. An effort is being made to obtain a segregate of the sulphides so that the chemist's present error of 0.05% will be divided by the ratio of the segregate to the entire pulp. Since much material less than 0.1% lead is handled, the subject is important.

INTERMOUNTAIN EXPERIMENT STATION, SALT LAKE CITY, UTAH

a. Microscopic and determinative work. In connection with most of the problems at Salt Lake City, Tucson, etc., it is necessary to know not only the chemical, but also the mineralogical composition of the ores, concentrates, etc. being handled. Information regarding the physical condition of materials and the interrelation of minerals in a sample, often highly essential data, can only be obtained by this method.

b. Lead-zinc sulphide separation by combined roasting and flotation. Treatment by which the specific gravity or physical condition of certain minerals will be so changed that the lead and zinc can be separated by flotation or concentration is being developed.

c. Development of a method for measuring work done in crushing and grinding. Since crushing and grinding are so fundamental to ore dressing, a knowledge of the amount of work expended is of fundamental value. There is at present no method for doing this.

d. Treatment of lead carbonate ores. Methods to render oxidized and carbonate ores of lead and zinc amenable to concentration by heat treatment are being devised.

e. Flotation fundamentals. Flotation is one of the important metallurgical processes today. Data regarding the effect of varying degrees of acidity and alkalinity, presence of soluble salts, different gangue minerals, etc., are of fundamental importance and are therefore being determined.

f. Flotation of sulphides of copper and their separation from the sulphides of iron. Data are being obtained regarding the relative flotability of various copper minerals and their action with various flotation reagents. From this, proper methods of separating these several minerals from pyrite can be devised.

g. Flotation of oxidized copper minerals. The effect of various flotation reagents on the floatability of the carbonate, oxide and silicate copper minerals is being studied. These data will be used in recovering such minerals as they occur associated with low-grade copper ores.

h. Effect of finely disseminated solids (slime) on the differential separation of lead, zinc and iron sulphides. The Bureau is determining whether or not the presence of slime has any marked effect on the floatability of sulphide minerals.

i. Effect of grain size on differential flotation. Data on the effect of floatability of the amount of surface exposed per mineral grain are being secured. These results will show the difference in floatability of minerals of large grain size as compared with the same mineral in finely divided form and give data regarding proper grinding practice for flotation.

j. Study of the roasting of zinc ores as a preparation for their hydrometallurgical treatment to secure maximum solubility of zinc. A study is being made of the variables entering into the roasting process to determine under what conditions a maximum solubility of zinc can be secured.

k. Brine-ferric chloride leaching of lead-zinc tailings for recovering lead and silver. This method offers a possibility for reclaiming these metals which are now wasted in tailings.

l. A study of the forms in which lead is now being lost in smelter slags. Any steps to reduce loss of lead in slag must be preceded by a knowledge of how it is lost. This is such a forerunner of conservation.

m. The manufacture of cheap calcium chloride and refrigeration to avoid losses of lead in brine leaching of lead ores. Another possibility of recovering lead now lost.

n. A study of the effect of certain factors on rod and ball mill crushing. Data are being secured on the effect of the rate of speed, thickness of pulp, and ball load in ball and rod mill crushing.

NORTHWEST EXPERIMENT STATION, SEATTLE, WASHINGTON

a. Study of the washability of fine sizes of coal on tables. Fundamental studies are being carried out on the tabling of coal. The relation of the specific gravity and the size of the particle to the distribution of coal and impurities on the table has been studied. Data have also been secured on the rang of sizes which can be satisfactorily treated in one operation, the method of handling slime, securing a satisfactory separation throughout the middle portion of the table, etc. This has led to greatly increased recovery of coal in washing operations.

b. Field investigations of coal washing methods. Many methods of coal washing are now in use. The collection of data on their performance in commercial operating plants and the particular sphere of usefulness of each enable the Bureau engineers to assist operating companies in securing the maximum efficiency in washing their particular coal.

c. Distribution of particles of various shapes and sizes on coal washing tables. This subject is being studied for both sized and unsized feed in order to obtain a knowledge of the mechanism of tabling coal which will lead to improved equipment and practice.

d. Stratification of particles on coal washing tables and its relation to the separation according to size, shape and specific gravity. Data on the effect on table stratification of depth of bed, stroke and speed, successive stratifications of the same material, particle travel, type of feed (size, etc.,) friction of deck covering and riffles, etc., are being obtained. An understanding of these fundamentals will lead to improved washing practice.

e. Study of briquetting in the Pacific Northwest. Many subbituminous coals common in the northwest have no market. It is hoped to develop a demand for them by briquetting. The effect of various binders must be carefully studied.

f. Measurement of the agglutinating value of coal. A standard method of determining the agglutinating value of coals is being developed, in order to determine by laboratory experiment the tendency of a coal to form coke.

g. Efficiency of heating kilns. The efficiencies of various types of fuels, methods of firing, etc., for different types of kilns and products is being obtained in order to secure maximum efficiency in the work.

h. Dewatering of clay suspensions by use of the spray separator. The washing of clay for purification purposes leaves a slime which must be dried. The possibilities of the spray evaporator are being investigated.

i. Improved methods for preparing ochers and similar mineral pigments of the Pacific Northwest. There is much opportunity for bettering the methods used in the preparation and purification of ochers.

SOUTHWEST EXPERIMENT STATION, TUCSON, ARIZONA

a. Reaction between magnetite and ferrous sulphide. The formation of magnetite in the copper converter during smelting is one of the most costly problems with which the operator is faced as it causes loss of valuable metals in the slag and of time in operation. A knowledge of the products formed in the above reaction and its rate under different conditions is fundamental data necessary before a solution can be reached.

b. The reaction between ferrous sulphide and sulphur dioxide. It has been proposed that SO_2 be used in place of air in the copper converter. This little understood reaction needs study in connection with devising proper equipment and processes.

c. The role of capillarity in leaching coarse cupriferous material. The action of capillarity determines the speed at which leach liquors enter the pieces of ore, and hence is an important factor in the rate of the leaching process. Conditions for maximum efficiency are being determined.

d. Diffusion as a factor in copper leaching. Equally as important as capillarity, is the effect of the diffusion rate of the enriched solution out of the ore lumps. The limitations placed on the process by this factor are being studied.

e. Oxidation and reduction of iron solutions in heap leaching. The rate of oxidation of the common sulphide minerals involved in leaching and their effec on the power of the solution to dissolve various copper minerals is being studied

f. Leaching of agglomerated finely divided material. There are hundreds of millions of tons of finely divided copper concentrator tailings in the southwest that cannot be leached in place because the heaps are impermeable to the passage of solutions. Preliminary tests indicate the possibility of agglomeratin such material cheaply, after which leaching methods may be applied.

g. Chemical methods of mineralogical analysis of copper ores and product To increase efficiency in the treatment of copper ores a knowledge of their mineral constituents is important. The best methods now in use for determining this are being tabulated and studied. New methods will be developed if necessary

h. Drilling and blasting drift rounds. The best form of drift round to be drilled, the best explosive to be used, and the best methods of loading the holes under different conditions are being determined.

Moscow Field Office

In addition to the above, the following work is carried out in a field office at Moscow, Idaho:

a. Effect of sieve motion on screening efficiency. A careful study is being made of the effect of different motions on the sieve analysis of pulverized material. Considerable differences have been found between several common methods.

b. Relation of table feed preparation to table concentration. Data are being secured on the effect on table concentration efficiency of the preparation of the feed. From these figures the conditions best adapted to table concentration will be evolved.

c. Experimental study of efficiency of closed circuit classifiers. There is at present no method for determining absolute efficiency of closed circuit classifiers. Such a method is being devised. As soon as its worth has been prove figures will be obtained showing the efficiency of classifiers now in use.

d. Ore-dressing problems of the Coeur d'Alene mining district. The losses in present ore dressing practice in this district are being located and remedial measures devised.

PETROLEUM EXPERIMENT STATION, BARTLESVILLE, OKLA.

a. Investigation of Methods of Handling Producing Wells.
b. Investigation of Mud Fluid for Oil and Gas Well Use.
c. Separation of Wax from Lubricating Wax Distillates.
d. Study of Crude Petroleum.
e. Shooting of Oil Wells.
f. Methods of Increasing the Recovery of Oil.
g. Investigation of Sulphur Compounds in Crude Oil.
h. Investigation of the Use of Gas for Lifting Oil.
i. Study of the Flow of Natural Gas Through Pipe Lines.
j. Study of Oklahoma Asphalt.
k. Study of Disposal of Oil Field Waters.
l. Study of Evaporation Losses of Petroleum and Gasoline.
m. Chemical Treatment of Light Petroleum Distillates.
n. Safety Work.

Dallas, Texas, Field Office

a. Engineering Reports on Producing Fields.

Laramie, Wyoming, Field Office

a. The Deposition of Paraffin in Oil Wells - The Cause, Effect, and Measures Used to Overcome the Resulting Difficulties.
b. Laboratory Study of Physical Characteristics of Paraffins and Waxes.
c. Study of Methods for Producing Flowing Wells in the Rocky Mountain Region.

San Francisco, California, Field Office

a. Salvages in the Oil Industry.
b. Engine Tests on Lubricating Oils.
c. Methods of Producing Oil Wells in California.
d. Bibliography of Petroleum and Allied Substances.
e. Safety in the Natural Gas Gasoline Industry.
f. Thermal Decomposition of Oil-Shale Kerogen.

Boulder and Rifle, Colorado, Field Offices

a. Investigations of Experimental Retorts and Development.
b. Refining Study and Analytical Distillation of Shale-Oil.
c. Assay Retort Studies.
d. Study of Nitrogen Compounds in Oil-Shale and Shale-Oil.
e. Extraction and Analysis of Kerogen.
f. Weathering Tests on Oil-Shales.
g. Effect of Inert Gases on Production of Oil from Oil-Shale.
h. Experimental Refining of Shale-Oil.

PACIFIC EXPERIMENT STATION, BERKELEY, CALIFORNIA

a. Reduction of Metal Oxides.
b. Reduction of Cuprous Oxides.
c. Specific Heats of Oxides and Sulphides.
d. Heats of Formation of Oxides and Sulphides.

SOUTHERN EXPERIMENT STATION, BIRMINGHAM-TUSCALOOSA, ALABAMA

a. Beneficiation of Low-Grade Bauxite.
b. Beneficiation of Low-Grade Phosphate Ores.
c. Coal Washing Problems in Alabama.

NORTH CENTRAL EXPERIMENT STATION, MINNEAPOLIS, MINNESOTA

a. Separation of Manganese, Iron and Phosphorus in High-Phosphorus Spiegel.
b. Resistance Offered to Flow of Gas by Columns of Irregular Solids.
c. Transfer of Heat from a Moving Gas Stream to a Column of Irregular Solids.
d. Kinetics of Iron Ore Reduction.
e. Comparative Desulphurizing Power of Blast-Furnace Slags Containing Small Percentages of Barium Oxide.
f. Plant Observations on the Reactions in the Iron Blast-Furnace.

NONMETALLIC MINERALS EXPERIMENT STATION, NEW BRUNSWICK, N. J.

a. Production and Use of Metallurgical Limestone.
b. Occurrence, Mining and Milling of Mica.
c. Application of the Wire Saw in Slate Quarrying.
d. Digest of Literature on Stassfurt and Alsatian Potash.
e. The Concentration and Treatment of Potash Ores.
f. A Field Study of the Utilization of Greensand.
g. The Effect of Anhydrite in Cement Retardation.

PITTSBURGH EXPERIMENT STATION, PITTSBURGH, PA.

Coal and Coal Products Research Section

Analytical Laboratory

a. Miscellaneous Analytical Work.
b. Coal Ash Fusibility as Related to Clinker Formation.

Microscopical Laboratory

a. Microscopic Studies of Coal.
b. Chemistry of Decay in Relation to Peat and Coal Formation.
c. Relation Between Composition and Oxidizability of Coal.

Coal Carbonization Laboratory

a. Spontaneous Combustion of Coal.
b. Determination of Reactivity of Coke in Air, Carbon-Dioxide and Water Vapor at Various Temperatures.
c. Oxidation of Sub-Bituminous Coal at Low Temperatures.
d. Survey of Methods for Determining Gas and Coke Making Properties of Coals.

Organic Chemistry Laboratory

a. Constitution of Low Temperature Tar.

Physical Chemistry Laboratory

a. Production of Methanol.

Health Laboratory Section

a. Miscellaneous Gas Analysis.
b. Miscellaneous Pathological Studies.
c. Routine Tests of Gas Masks and Dust Respirators.
d. Physiological Effect of Various Dusts on Animals.
e. Experimental Effect of Oxygen Upon Animals.
f. Disposal of Waste Waters from Mines.
g. Sealing Abandoned Mines and Determining the Cause of Alkalinity in Others.
h. Pathology of Carbon Monoxide Poisoning.
i. Relative Toxicity of Methyl Chloride, Ethyl Chloride, Methyl Bromide and Ethyl Bromide.
j. Temperature and Humidity Investigation.
k. Carbon Monoxide Recorder.
l. Occluded Gases in Coal as Affecting Inflammability of Its Dust.
m. Warning Agents for Manufactured Gas.
n. Sulfur Dioxide in Air.
o. Catalysts for Automobile Exhaust.

Explosive Section

a. Tests of Explosives to Determine Their Permissibility for Use in Coal Mines.
b. Analysis of Explosives and Explosive Materials.
c. Collecting and Testing Field Samples of Permissible Explosives.
d. Factors Influencing the Nature and Quantity of Poisonous Gases Liberated by Explosives Under Mining Conditions.
e. Determination of Limit Charge Curves for Permissible Explosives in Varying Gas-Air Mixtures.
f. Investigation of Explosions Due to Explosives.
g. Photographic Study of the Process of Ignition of Gas-Air Mixtures by Explosives.
h. Investigation of New Explosives and of New Components for Explosive Mixtures.

i. Effect of Carbon Dioxide, Nitrogen and Helium on the Limits of Inflammability of Carbon Monoxide and Hydrogen.
j. Determination of the Temperature Attained by the Products of Detonation of Explosives.
k. Effect of Confinement and Nature of Stemming and Tamping on the Charge Limits of Explosives.
l. Velocity of Detonation Across a Gas-Gap Between Two Cartridges of Explosives.
m. Metal Mine Explosives and Blasting Methods.
n. Development of Analytical Testing Methods.
o. Relation Between Oxygen Balance and Explosive Properties of Eight Samples of Forty Per Cent Gelatin Dynamite.

Fuel Section

a. Refractory Service Survey in Boiler Furnaces.
b. Soot Remover and Soot Prevention Compounds.
c. Heat Flow Meters for Furnace Walls.
d. Tests of Secondary Air Devices for Domestic Furnaces.
e. Coal Ash Fusibility as Related to Clinker Formation.
f. Determination of Relative Availability of Cokes for Use in Domestic Heating Furnaces.
g. Rating of Low Pressure Heating Boilers.

Metallurgical Section

a. Study of the Cause and Control of Abnormality in Case Carburized Steel.
b. Equilibrium Between Iron, Manganese and Sulphur.
c. Physical Chemistry of Steel Making.
d. Distribution of Iron Oxide Between Slag and Metal.
e. Formation and Identification of Non-Metallic Inclusions.
f. Viscosity of Open-Hearth Slags.

Coal Analysis Section

a. Laboratory Work on Coal Analyses.
b. Development of Methods and Equipment.

Physical Section

Physical Laboratory

a. Accuracy of Manometry of Explosions.
b. Relative Ignitability and Pressure Developed in the Flammation of Low-Temperature Coke as Compared to Coal.
c. Routine Calibration.

Cryogenic Laboratory

a. Vapor-Pressure Composition Relations for Methane-Ethane Mixtures.
b. Vapor-Pressure Composition Relations for Methane-Nitrogen Mixtures.
c. Specific Heat of Liquid Ethane.
d. Removal of Carbon Dioxide from Natural Gas by Refrigerating Organic Solvents.
e. Search for Neon in Natural Gas.
f. Heat Transfer at Low Temperatures.

Experimental Mine Section

a. Efficacy of Devices for Arresting an Explosion After it Has Traveled Some Distance.
b. Behavior of Different Coal Dusts as Regards Propagation of Flame.
c. Recirculation of Air by Auxiliary Fans.

Electrical Section

a. Routine Tests and Approval of Apparatus.
b. Ignition of Methane by Heated Surfaces.
c. Adequacy of Flame Safety Lamps for Gasoline Vapors.

Mining Research Section

a. Comparative Efficiency of Storage Battery and Trolley Mine Power.
b. Coal Mine Ventilation Factors.
c. Operation of Mine Fans.

Falls of Roof and Coal Section

a. Falls of Roof and Coal.

RARE AND PRECIOUS METALS EXPERIMENT STATION, RENO, NEVADA

a. Precious Metal Loss in Present Milling Practice.
b. Cyanide Recovery of Precious Metals Associated with Minor Copper Values.
c. Metallurgy of Chromium.
d. Recovery of Radium Now Wasted.
e. Centrifugal Concentration.
f. Hydrometallurgy of Manganese.
g. Oil Bleaching Clays.
h. Identification of Rare and Non-Metallic Minerals.

MISSISSIPPI VALLEY EXPERIMENT STATION, ROLLA, MO.

a. Concentration of Fluorspar Ores in the Illinois-Kentucky District.
b. Improvements in the Milling of Southeast Missouri Lead Ores.
c. Improvement of Milling Practice in the Tri-State Zinc District.
d. Gravity Concentration of Oxidized Zinc Ores Occurring at Granby, Mo.
e. Means of Making a Segregate Preparatory to Chemical Analysis of the Sulphide Minerals in a Low-Grade Domestic Ore-Pulp Containing Lead, Zinc and Copper.

INTERMOUNTAIN EXPERIMENT STATION, SALT LAKE CITY, UTAH

a. Microscopic and Determinative Work.
b. Lead-Zinc Sulphide Separation by Combined Roasting and Flotation.
c. Development of a Method for Measuring Work Done in Crushing and Grinding.
d. Treatment of Lead Carbonate Ores.
e. Flotation Fundamentals.
f. Flotation of Sulphides of Copper and Their Separation from the Sulphides of Iron.
g. Flotation of Oxidized Copper Minerals.
h. Effect of Finely Disseminated Solids (Slime) on the Differential Separation of Lead, Zinc and Iron Sulphides.
i. Effect of Grain Size on Differential Flotation.
j. Study of the Roasting of Zinc Ores as a Preparation for Their Hydrometallurgical Treatment to Secure Maximum Solubility of Zinc.
k. Brine-Ferric Chloride Leaching of Lead-Zinc Tailings for Recovering Lead and Silver.
l. A Study of the Forms in Which Lead is Now Being Lost in Smelter Slags.
m. The Manufacture of Cheap Calcium Chloride and Refrigeration to Avoid Losses of Lead in Brine Leaching of Lead Ores.
n. A Study of the Effect of Certain Factors on Rod and Ball Mill Crushing.

NORTHWEST EXPERIMENT STATION, SEATTLE, WASHINGTON

a. Study of the Washability of Fine Sizes of Coal on Tables.
b. Field Investigations of Coal Washing Methods.
c. Distribution of Particles of Various Shapes and Sizes on Coal Washing Tables.
d. Stratification of Particles on Coal Washing Tables and Its Relation to the Separation According to Size, Shape and Specific Gravity.
e. Study of Briquetting in the Pacific Northwest.
f. Measurement of the Agglutinating Value of Coal.
g. Efficiency of Heating Kilns.
h. Dewatering of Clay Suspensions by Use of the Spray Separator.
i. Improved Methods for Preparing Ochers and Similar Mineral Pigments of the Pacific Northwest.

SOUTHWEST EXPERIMENT STATION, TUCSON, ARIZONA

a. Reaction Between Magnetite and Ferrous Sulphide.
b. The Reaction Between Ferrous Sulphide and Sulphur Dioxide.
c. The Role of Capillarity in Leaching Coarse Cupriferous Material.
d. Diffusion as a Factor in Copper Leaching.
e. Oxidation and Reduction of Iron Solutions in Heap Leaching.
f. Leaching of Agglomerated Finely Divided Material.
g. Chemical Methods of Mineralogical Analysis of Copper Ores and Products.
h. Drilling and Blasting Drift Rounds.

Moscow, Idaho, Field Office

a. Effect of Sieve Motion on Screening Efficiency.
b. Relation of Table Feed Preparation to Table Concentration.
c. Experimental Study of Efficiency of Closed Circuit Classifiers.
d. Ore-dressing Problems of the Coeur d'Alene Mining District.

Information Circular, Bureau of Mines, Department of Commerce.